

Iowa Technical Note No. 25

Iowa Phosphorus Index

Purpose

The purpose of Iowa phosphorus (P) index is to assess the risk of P delivery to surface waters. The index is a tool to help conservation planners, landowners/landusers and others to evaluate the current risk from P reaching surface water from a specific site, and to determine factors which dominate the risk due to P transport to surface waters. It will also assist landowners/landusers in making management decisions to reduce the risk.

Background

Phosphorus is an important nutrient needed for crop production and many fertilizers and organic sources can be used to supplement the supply of available P in soils. However, there are environmental concerns when excessive amounts of P (and other nutrients) from various sources reach surface waters. Phosphorus from soil, manure, fertilizer, and runoff, or subsurface flow that reaches surface water can produce eutrophication. Eutrophication is defined as an increase in the fertility status of natural waters that causes accelerated growth of algae or aquatic plants. In most fresh surface water systems (lakes, ponds, and streams), the excessive growth of algae or aquatic plants is directly related to levels of P. Large inputs of P to surface waters from nonpoint sources such as agricultural fields can elevate the P concentration in the water above critical levels for aquatic plant growth and thus enhance the development of eutrophication.

The challenge to producers and agriculturists is to develop a plan that efficiently utilizes all sources of nutrients and at the same time maintains or increases agricultural profitability and environmental quality.

The P index is an integrated approach to estimating the risk of P delivered to surface water from agricultural fields. This tool was developed to assess the potential for P moving from individual fields based on selected soil and field characteristics and on management practices. The P index is much more comprehensive than relying only on soil test P (STP) because it integrates many soil and field characteristics that influence potential P movement to surface waters. These characteristics include source factors such as soil test P, total soil P, rate, method, and timing of P application (fertilizer, manure, and other organic sources), and erosion. They also include transport factors such as sediment delivery, relative field location in the watershed, soil conservation practices, precipitation, runoff and tile flow/subsurface drainage. Use of the P index provides a means of identifying fields that have a low to moderate potential for P delivered to surface water, as well as fields that have very high risk of P loss and, therefore, require conservation practices and/or limits to manure or fertilizer P. The P index provides a relative rating as to the risk of P moving from individual fields, which can be used to prioritize fields for nutrient and soil management practices. Because of the integrated system, the P index is useful for understanding the processes causing a high P delivery to surface water, and can help identify management practices to lower that risk. Ultimately, use of the P-index should reduce risks of P delivered to surface water, improve or maintain water quality, and provide producers options for improved P management.

Basic Concepts Underlying the Iowa Phosphorus Index

The current version of the P index is based on available research data and scientific judgment. Ongoing research designed to validate the various components of the index will produce results useful to modify the index. Current knowledge about the processes that are conducive to P delivered to surface waters has determined the main characteristics and underlying concepts of the Iowa P index. Some of the most important concepts can be summarized in the following four points.

1. The Iowa P index uses source and transport factors to approximate P loads to surface waters and to establish five risk classes. The source factors are arranged in a multiplicative manner within three components that represent the main transport mechanisms: 1) Erosion Component (sediment loss), 2) Runoff Component (water loss), and 3) Subsurface Drainage Component (water movement through tile and/or coarse subsoil/substrata). These components of the index yield relative risk of loss by approximating potential P delivered to surface water. The index sums the three components to get an overall estimate of P delivery to surface water, which will be placed into five risk classes (very low to very high). These classes are based on current knowledge concerning P loads to surface water from watersheds with varying degrees of eutrophication. The index units are approximated in lb/P/acre/yr for assumed long-term average conditions. The index is not intended to be used for prediction of actual P delivered to surface water from fields.
2. The index incorporates tools currently used by the Natural Resources Conservation Service (NRCS) to estimate the impact of landforms, soil map units, and management practices on soil and water loss from fields. These tools have been modified as needed to estimate these losses for the most representative area of individual agricultural fields. Appropriate use of the Index requires a recent measurement of soil test P using procedures suggested for crop production by Iowa State University.
3. The index considers loss of P dissolved in water runoff or subsurface drainage water that is readily available for algae growth. It also considers the proportion of the P in soil sediment (particulate P) delivered through erosion processes that likely will be released to the water over a period of time. Thus, the index will weigh particulate P losses very heavily when erosion risk is high and the impact of increased soil P associated with high soil P test levels.
4. The current version of the index does not differentiate between commonly used P sources, and gives similar weight to fertilizer, manure, and other organic sources. It is recognized that differences in water solubility of P may influence the short-term impact of P applications on P delivered to surface water through runoff or subsurface drainage, although not necessarily long-term losses through these processes or with eroded sediment. Ongoing research should provide information to modify future versions of the index as needed.

The Iowa Phosphorus Index

Only a brief explanation of the underlying equation and terms of the P index (PI) is provided here. More detailed background and explanations, including known improvements to be included in the future, are provided in the document “Background and Basic Concepts of the Iowa P Index”.

The P Index is designed to be used on a field basis or Conservation Management Units (CMU). A CMU is a portion of a field, field, group of fields, or other land units of the same landuse and having

similar treatment needs and management plans. When using the PI on a field or CMU, the factors to calculate the erosion rate will be determined from the “dominate critical area” as defined in the Field Office Technical Guide (FOTG) and will be used for the rill and interrill erosion for the Erosion Component of the PI equation.

Erosion Component + Runoff Component + Subsurface Drainage Component = P Index

1. Erosion Component (Potential P delivered to surface water with sediment):

Gross erosion x (Sediment trap factor or SDR) x Buffer factor x Enrichment factor x STP Erosion factor

Gross erosion is estimated using the NRCS Field Office Technical Guide (FOTG) to calculate soil loss. The Revised Universal Soil Loss Equation Version 2 (RUSLE2) or current erosion prediction tool used by NRCS will be used to determine rill and interrill erosion. Ephemeral gullies, and classical gully erosion are determined by the Gully Erosion procedures outlined in section I-C-3 of the FOTG. Gross erosion is the sum of soil loss from rill and interrill erosion, ephemeral gullies and classical gully reported in tons/acre/year. Gully erosion is prorated over the entire field or conservation management unit.

Sediment trap factor accounts for the sediment captured by certain conservation practices. **Table 1** lists the acceptable practices and factors. The factor applies to the area affected by the conservation practice. Fields should be subdivided by CMU to reflect the different treatment units. If a factor for sediment trap efficiency is used, then the sediment delivery ratio defaults to 1.0.

Sediment delivery ratio (SDR) is derived from **Figure 1** and **Figure 2**. The data adapt the use of SDR from watersheds to individual fields by transforming area to linear distance from the center of the field to the nearest perennial, or intermittent channeled stream downslope, by major Iowa landform region (Figure 1). The output values from Figure 2 range from 0.03 to 1.0, with 1.0 for distances <60 feet.

Buffer factor refers to a vegetative buffer that meets NRCS standards for filter strips. Three classes, arranged by buffer width are listed in **Table 2** with the corresponding buffer factor.

Enrichment factor accounts for the increase in the proportion of fine soil particles in eroded sediment, which tend to have a higher concentration of P when certain land treatments are present. Five classes ranging from 1.1 to 1.3 according to cover or tillage utilized and presence or absence of a buffer strip are shown in **Table 3**.

Soil Test P (STP) Erosion factor represents the amount of particulate P in delivered sediment that likely will be released to the water over a long period of time. It is estimated as 70% of the total P concentration of the sediment, based on an average amount of total P (with low STP) in the surface 6-inch layer of soil and a recent measurement of STP. The average total P value is increased according to the recent STP value using a coefficient to transform STP to increased total P. The Bray P-1, Mehlich-3, Mehlich-3-ICP, or Olsen test methods can be used. The model reflects that about 30% of the total P is typically tightly bonded to soil particles, and is not likely to become available for aquatic ecosystems. For a certain test value, the factors are the same for the Bray P-1 and Mehlich-3, higher for the Olsen since the Olsen test extracts less P, and lower for the Mehlich-3-ICP since it measures more P. The value for the STP Erosion factor can be found in **Table 4**.

2. Runoff Component (Potential P delivered to surface water in runoff):

Runoff factor x Precipitation x (STP Runoff factor + P Application factor)

Runoff factor uses the NRCS Runoff Curve Number (RCN) to convert precipitation to a fraction of water that runs off a field. It is estimated that 50% of the total rainfall will not produce runoff. The Runoff factor has been adjusted by 0.5 to account for this reduction. See **Figure 3** to determine the runoff from RCN.

Precipitation is the 30-year average annual precipitation for each county divided by the constant 4.415 to convert inches of rain to million lb of water/acre. Precipitation for each county can be selected from **Figure 4**.

STP Runoff factor consists of total dissolved P concentration in runoff estimated from STP (6-inch depth) results from the Bray P-1, Mehlich-3, Mehlich-3-ICP, or Olsen test methods. The STP runoff factor is taken from **Table 5**, with the appropriate factor determined by the soil test method used.

P application factor is an estimate of the additional impact of recent P applications on STP. The value of the factor is zero when there was no P application since the last time the soil was tested. The P application factor can be determined from **Table 6**.

3. Subsurface Drainage Component (Potential P delivered to surface water with subsurface drainage):

Precipitation x Flow factor x STP Drainage factor

Precipitation is the 30-year average annual precipitation for each county divided by the constant 4.415 to convert inches of rain to million lb of water/acre. Precipitation for each county can be selected from **Figure 4**.

Flow factor is determined by presence or absence of subsurface/substrata flow. If tiles or coarse textured soils are known to be present, then the flow factor is 0.1, it is assumed that the flow is 10% of the precipitation. If it is unknown whether tile is present the evaluator can review **Table 7**. It contains a list of soil map units that have 5% or less slopes, 40% clay or coarser, and are poor or very poor in natural drainage. If one of the listed map units is present, predominate in the field, and the field is cropped the assumption is that some tile must be present. To determine if subsurface drainage is occurring from coarse-textured subsoil/substrata determine if the predominate soil is listed in **Table 8**. If yes for tile or coarse subsoil/substratum the flow factor is 0.1. If no the value is 0.0.

STP Drainage factor consists of two classes with a value of 0.1 or 0.2. The factor value is 0.1 if STP < 100 ppm Bray-1 or Mehlich-3, <118 ppm Mehlich-3-ICP or < 60 ppm Olsen P. The factor value is 0.2 if STP ≥ 100 ppm Bray-1 or Mehlich-3, ≥118 ppm Mehlich-3-ICP or ≥ 60 ppm Olsen P.

Procedure for making an assessment

Erosion Component

Gross Erosion	X	Sediment Trap Factor or SDR	X	Buffer Factor	X	Enrichment Factor	X	STP Erosion Factor	=	Erosion Component
Estimate gross erosion using the NRCS FOTG to calculate the sum of RUSLE2, Ephemeral, and Classic Gully in tons/acre/year.		Select landform from Figure 1 , determine distance to perennial or intermittent channeled stream and select factor from Figure 2 . If Conservation Practices are present that will affect sediment trap efficiency, select trap factor from Table 1 instead of SDR factor.		Determine presence of buffer, buffer width and select buffer factor from Table 2 .		Determine tillage and presence of buffer and select from Table 3 . Buffer must be at least 20 ft in width.		Determine type of soil test method (Bray 1-P, Mehlich-3, Mehlich-3-ICP or Olsen) and Soil Test P in ppm and select factor from appropriate column in Table 4 .		
	X		X		X		X		=	TOTAL

Runoff Component

Runoff Factor	X	Precipitation	X	(STP Runoff Factor	+	P Application Factor)	=	Runoff Component
From Figure 3 use the RCN to determine runoff factor.		Select county precipitation factor from Figure 4 .		Determine soil test method (Bray 1-P, Mehlich-3, Mehlich-3-ICP or Olsen) and STP in ppm and select factor from appropriate column in Table 5 .		Determine rate, method, and timing and select factor from Table 6 .		
	X		X	(+)	=	TOTAL

Subsurface Drainage Component

Flow Factor	X	Precipitation factor	X	STP Drainage Factor	=	Subsurface Drainage Component
If it is unknown whether tile is present the evaluator can review Table 7. It contains a list of soil map units that have 5% or less slopes, 40% clay or coarser, and are poor or very poor in natural drainage. If one of the listed map units is present, is predominant in the field and the field is cropped, the assumption is that some tile must be present. If yes enter 0.1. If no, enter 0.0		Select County Precipitation from <i>Figure 4</i> .		Determine STP in ppm and the type of soil test. (Bray 1-P, Mehlich-3, Mehlich-3-ICP or Olsen)		
If it is unknown whether subsoil/substrata is coarse textured refer to <i>Table 8</i> . To determine if subsurface drainage is occurring from coarse-textured subsoil/substrata determine if the predominant soil is listed in Table 8. If yes enter 0.1. If no, enter 0.0				Use a factor of 0.1 if the Mehlich-3-ICP is < 118 ppm or the Bray P-1 or Mehlich-3 is < 100 ppm or the Olson is < 60 ppm or a factor of 0.2 if the Mehlich-3-ICP is ≥ 118 ppm or the Bray P-1 or Mehlich-3 is ≥ 100 ppm or the Olsen P is ≥ 60.		Total
	X		X		=	

Erosion Component	+	Runoff Component	+	Subsurface Drainage Component	=	TOTAL PI
	+		+		=	

Risk Assessment:

- Very Low** 0-1
- Low** >1-2
- Medium** >2-5
- High** >5-15
- Very High** >15

INTERPRETATIONS OF SITE VULNERABILITY RATINGS FOR THE P INDEX

VERY LOW – 0-1 A field in which movement of P off site will be VERY LOW. If soil conservation and P management practices are maintained at current levels, impacts on surface water resources from P losses from the field will be small.

LOW – >1-2 A field in which movement of P off site will be LOW. Although the P delivery to surface water bodies is greater than from a field with a very low rating, current soil conservation and P management practices keep water quality impairment low.

MEDIUM – >2-5 A field in which movement of P off-site will be MEDIUM. Impacts on surface water resources will be higher than for the field with a low rating, and the P delivery potential may produce some water quality impairment. Careful consideration should be given to further soil conservation and P management practices that do not increase P delivery to surface water.

HIGH – >5-15 A field in which movement of P offsite will be HIGH. Water quality impairment will be large. Remedial action is required to reduce P movement to surface water bodies. New soil and water conservation and/or P management practices are necessary to reduce offsite P movement and water quality degradation.

VERY HIGH – >15 A field in which movement of P offsite will be VERY HIGH. Impacts on surface water resources are extreme. Remedial action is required to reduce P delivery to surface water. All necessary soil and water conservation practices plus a P management plan, which may require discontinuing P applications, must be put in place to reduce water quality impairment.

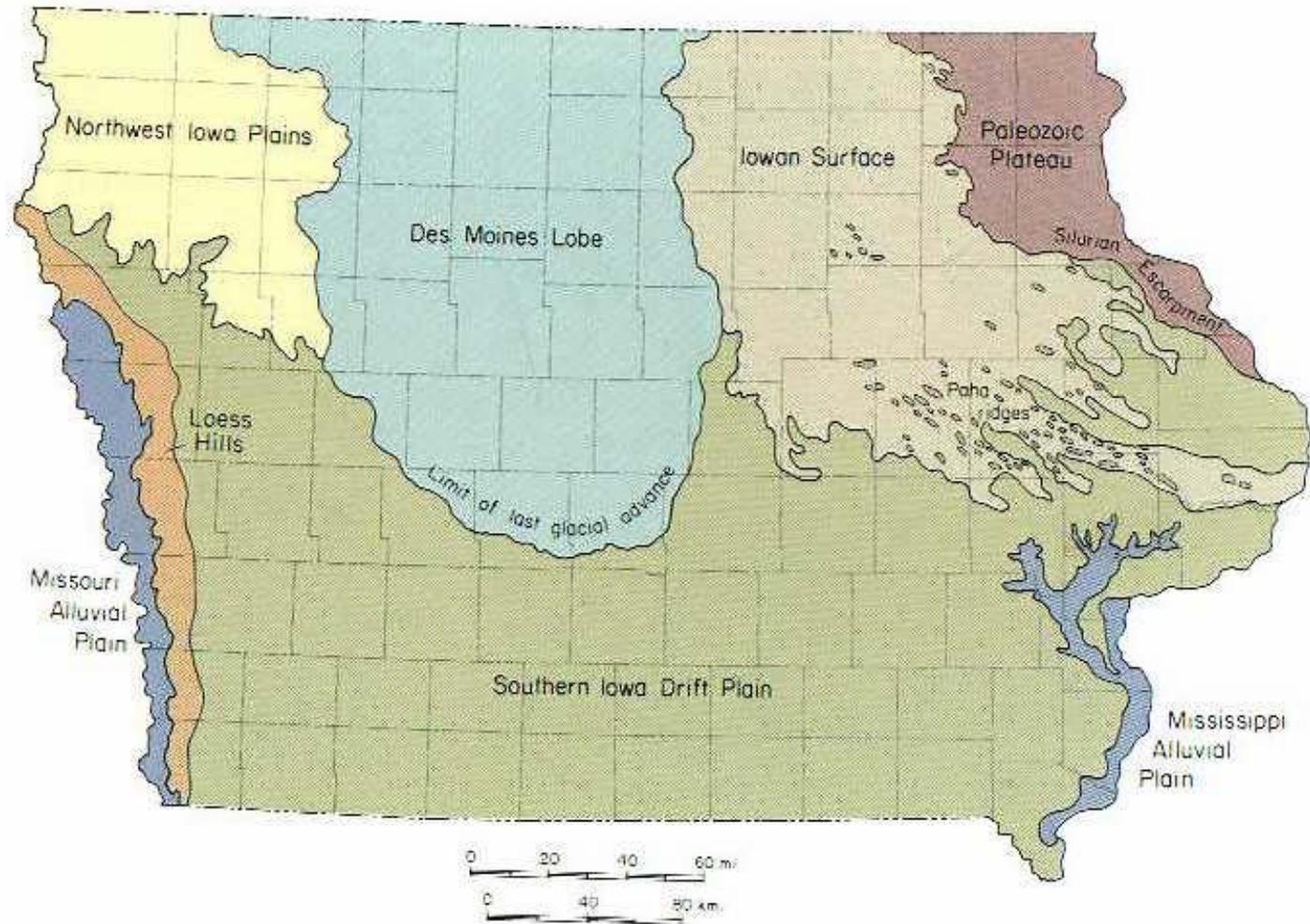
NOTE: See NRCS Nutrient Management Standard 590 for nutrient management recommendations.

PRECAUTIONS IN THE USE OF THE PHOSPHORUS INDEX

The P index is intended to be part of the NRCS nutrient management planning process that takes place between the land user and resource planner. It can be used to communicate the concepts, processes, and results that can be expected if various alternatives are implemented in the management of the natural resources at the site.

THE P INDEX IS NOT INTENDED TO BE AN EVALUATION SCALE FOR DETERMINING WHETHER LANDUSERS ARE COMPLYING WITH WATER QUALITY OR NUTRIENT MANAGEMENT STANDARDS ESTABLISHED BY LOCAL, STATE, OR FEDERAL AGENCIES. Use of this P index as a regulatory tool would be beyond the concept and philosophy of the working group that developed it. This P Index has been adapted to local conditions from appropriate regional and available in-state research. This version of the Index should be tested and modified periodically as new research data become available.

FIGURE 1. Iowa Land Form Regions



Landform Regions of Iowa

Figure 2, Sediment Delivery Ratio Factor

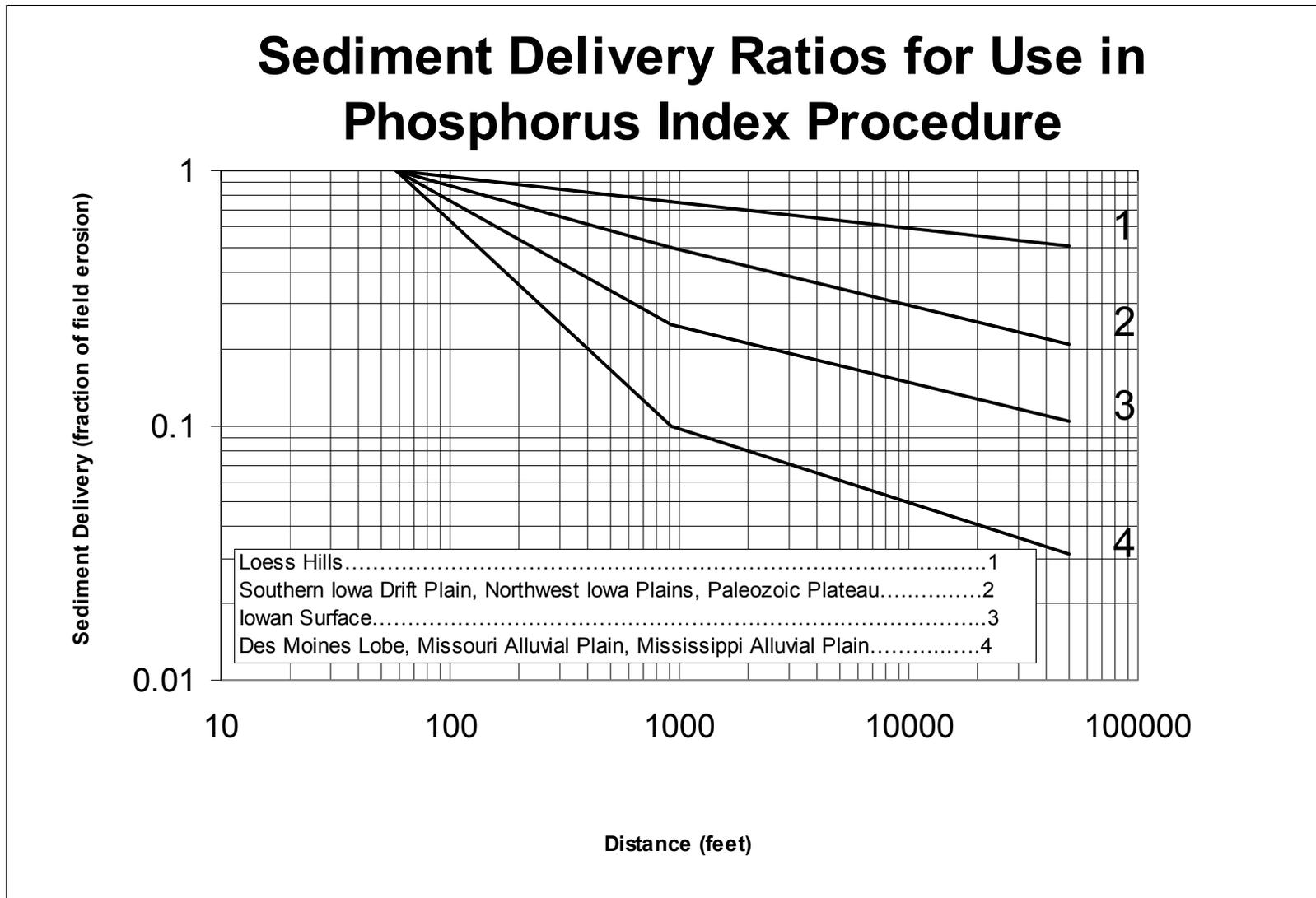


Figure 3, Surface Runoff Using Runoff Curve Numbers

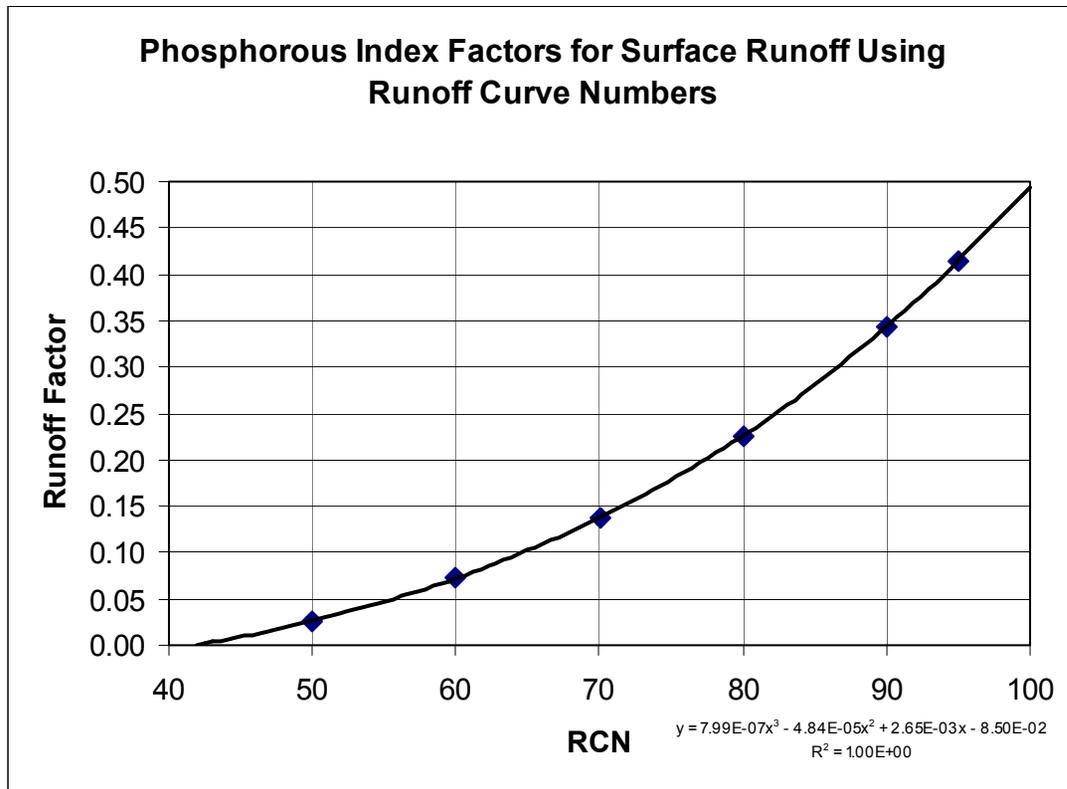


Figure 4, Precipitation 30 Year Average Annual (millions pounds/acre)

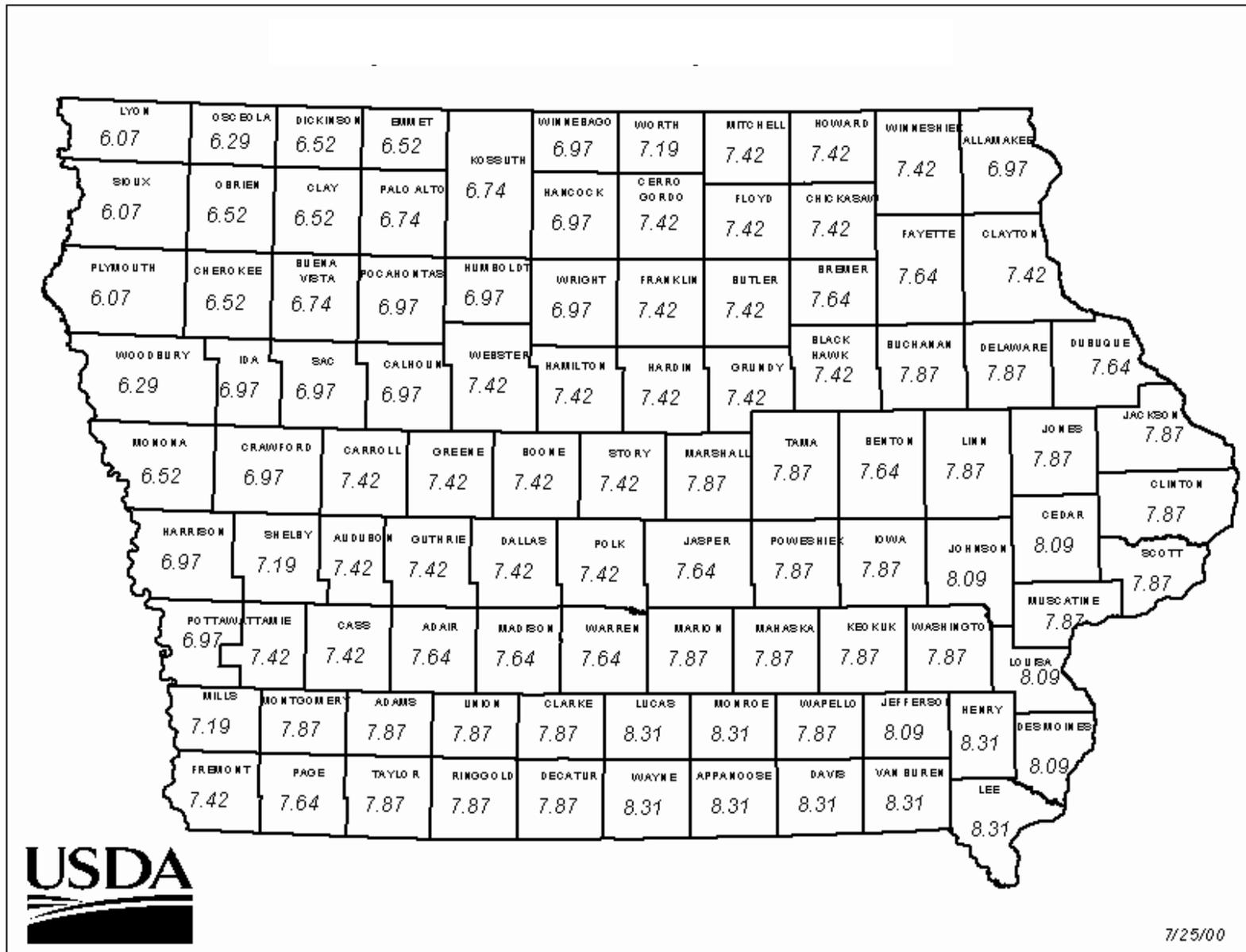


TABLE 1, Sediment Trap Factor

Conservation Practice	Trapping Factor
Level Terrace	0
Ponds Grade Stabilization Impoundment Tile Inlet Terrace	0.05
Water & Sediment Control Basin	0.2
Grade Stabilization Full Flow Graded Terrace Diversion	1

TABLE 2, Buffer Factor

Buffer Width	Factor
0-19 feet	1.0
20-75 feet	0.7
>75 feet	0.5

TABLE 3, Enrichment Factor

Management Treatment	Factor
Forage/Grass	1.3
With Buffer and No-Till	1.3
Without Buffer and No-Till	1.2
With Buffer and Tillage used	1.2
Without Buffer and Tillage used	1.1

Note: For buffers \geq 20 feet in width.

Table 4 STP Erosion Factor

STP from 6 to 7 inch sample depth		
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(Includes 2,000/1,000,000 conversion factor)

(Includes 30% non-available P -- to aquatic organisms)

4/19/2004

Erosion Factor for Soil Test P

Bray-1 P	STP		STP		STP
Mehlich-3	Erosion	Olsen	Erosion	Mehlich-3	Erosion
STP	Factor	STP	Factor	ICP	Factor
ppm		ppm		ppm	
0	0.70	0	0.70	0	0.70
5	0.72	5	0.74	5	0.70
10	0.74	10	0.77	10	0.70
15	0.76	15	0.81	15	0.72
20	0.78	20	0.84	20	0.74
25	0.81	25	0.88	25	0.76
30	0.83	30	0.91	30	0.78
35	0.85	35	0.95	35	0.80
40	0.87	40	0.98	40	0.82
45	0.89	45	1.02	45	0.84
50	0.91	50	1.05	50	0.86
60	0.95	60	1.12	60	0.89
70	0.99	70	1.19	70	0.93
80	1.04	80	1.26	80	0.97
90	1.08	90	1.33	90	1.01
100	1.12	100	1.40	100	1.05
125	1.23	125	1.58	125	1.15
150	1.33	150	1.75	150	1.24
175	1.44	175	1.93	175	1.34
200	1.54	200	2.10	200	1.44
250	1.75	250	2.45	250	1.63
300	1.96	300	2.80	300	1.83
350	2.17	350	3.15	350	2.02
400	2.38	400	3.50	400	2.22
450	2.59	450	3.85	450	2.41
500	2.80	500	4.20	500	2.61
600	3.22	600	4.90	600	2.99
700	3.64	700	5.60	700	3.38
800	4.06	800	6.30	800	3.77
900	4.48	900	7.00	900	4.16

Table 5. STP Runoff Factor
STP from 6-7 inch sample depth
Includes 2,000/1,000,000 conversion factor

STP from 6 to 7 inch sample depth	
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4/19/2004

Runoff Factor for Soil Test P

Bray-1 P	STP		STP		STP
Mehlich-3 STP	Runoff Factor	Olsen STP	Runoff Factor	Mehlich-3 ICP STP	Runoff Factor
ppm		ppm		ppm	
0	0.05	0	0.05	0	0.05
5	0.08	5	0.09	5	0.05
10	0.10	10	0.13	10	0.05
15	0.13	15	0.18	15	0.07
20	0.15	20	0.22	20	0.10
25	0.18	25	0.26	25	0.12
30	0.20	30	0.30	30	0.14
35	0.23	35	0.34	35	0.17
40	0.25	40	0.38	40	0.19
45	0.28	45	0.43	45	0.21
50	0.30	50	0.47	50	0.24
60	0.35	60	0.55	60	0.28
70	0.40	70	0.63	70	0.33
80	0.45	80	0.72	80	0.37
90	0.50	90	0.80	90	0.42
100	0.55	100	0.88	100	0.47
125	0.68	125	1.09	125	0.58
150	0.80	150	1.30	150	0.70
175	0.93	175	1.51	175	0.81
200	1.05	200	1.72	200	0.93
250	1.30	250	2.13	250	1.16
300	1.55	300	2.55	300	1.39
350	1.80	350	2.97	350	1.62
400	2.05	400	3.38	400	1.86
450	2.30	450	3.80	450	2.09
500	2.55	500	4.22	500	2.32
600	3.05	600	5.05	600	2.78
700	3.55	700	5.88	700	3.25
800	4.05	800	6.72	800	3.71
900	4.55	900	7.55	900	4.17

Table 6, P Application Factor

Runoff Factor for P Application Rate and Method of Application

P Application Rate lb P ₂ O ₅ /acre	Incorporate or Inject Within 24 Hours	Incorporate Within One Week	Surface Application No Incorporation	Surface Application Frozen/Snow Covered, Saturated, or Floodplain
0	0.00	0.00	0.00	0.00
10	0.00	0.00	0.01	0.01
20	0.00	0.01	0.01	0.02
30	0.01	0.01	0.02	0.02
40	0.01	0.01	0.02	0.03
50	0.01	0.02	0.03	0.04
60	0.01	0.02	0.03	0.05
70	0.02	0.02	0.04	0.06
80	0.02	0.03	0.04	0.07
90	0.02	0.03	0.05	0.07
100	0.02	0.03	0.05	0.08
120	0.03	0.04	0.07	0.10
140	0.03	0.05	0.08	0.11
160	0.03	0.05	0.09	0.13
180	0.04	0.06	0.10	0.15
200	0.04	0.07	0.11	0.16
220	0.05	0.07	0.12	0.18
240	0.05	0.08	0.13	0.20
260	0.06	0.09	0.14	0.21
280	0.06	0.09	0.15	0.23
300	0.07	0.10	0.16	0.25

Table 7, Soils listing for estimating presence of tile.

Soils Data of subsoil grouping by drainage class

It contains a list of sorted soil names (and a list of associated county numbers) where:

Slope Range High :	Less than 5%	and
Drainage Class :	Poor, Poor-Very poor, or Very Poor	and
Subsoil Groups :	1 or 2 (Clay < 40%)	

From the Iowa Soil Properties And Interpretations Database (ISPAID) 7.0 Manual:

21 Slope Range (%) High [SLOPERNGH]

The grade or slope of the surface of a soil. It is expressed in percentages of slope which equal the number of feet of fall per 100 feet of horizontal distance.

41 Subsoil Group (B Horizon only) [SUBSOILGRP]

[Subsoil group listed for complexes is the most limiting group of the soils identified in the map unit name]

(i.e., Steinauer = 1 and Shelby = 2; Steinauer-Shelby complex = 2.)]

1 = Subsoil texture about the same as surface soil texture, not more than 34% clay, subsoil favorable for crop growth.

2 = Subsoil moderately unfavorable for crop growth: slow permeability [35-40% clay content] or high plasticity.

3 = Subsoil very unfavorable for crop growth: silty clay and clay textures, very slow permeability [>40% clay content], or high plasticity.

58 Drainage Class (Natural) Code [DRNCLSCD]

Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. [The drainage class listed for complexes is the most limiting class of the soils identified in the map unit name (i.e., Ackmore = SP-P and Colo = P; Ackmore-Colo complex = P).]

Drainage class abbreviations and code numbers assigned follow.

E	= 10	= Excessive
E-SE	= 15	= Excessive-Somewhat excessive
SE	= 20	= Somewhat excessive
SE-W	= 25	= Somewhat excessive-Well
W	= 30	= Well
W-MW	= 35	= Well-Moderately well
MW	= 40	= Moderately well
MW-SP	= 45	= Moderately well-Somewhat poor
SP	= 50	= Somewhat poor
SP-P	= 55	= Somewhat poor-Poor
P	= 60	= Poor
P-VP	= 65	= Poor-Very poor
VP	= 70	= Very poor

ACKMORE	0-2%	P	1	5, 14, 47, 86
ACKMORE	2-5%	P	1	47, 86
ACKMORE-COLO COMPLEX	0-2%	P	1	79
ACKMORE-COLO COMPLEX	2-5%	P	1	50, 64, 86
ACKMORE-COLO COMPLEX CHANNEL	2-5%	P	1	50
ACKMORE-COLO-JUDSON	0-5%	P	1	78
ACKMORE-COLO-JUDSON	2-5%	P	1	69
ACKMORE-JUDSON COMPLEX	1-5%	P	1	14
ADRIAN	0-1%	VP	1	41
AFTON	0-2%	P	2	11, 18, 21, 47, 60, 71, 72, 81, 84
ALBATON AND SARPY SOILS	0-2%	P	1	43
ALBATON OVERWASH	0-2%	P	1	78
AMBRAW	0-2%	P	1	23, 29, 58, 70, 82
AMBRAW RARELY FLOODED	0-2%	P	1	58, 70
AMBRAW-PERKS-LAWSON FF	0-2%	P	1	82
ANSGAR	0-1%	P	2	53
ANSGAR	0-2%	P	2	16, 35, 66
ANSGAR	0-3%	P	2	23, 52
AQUOLLS, PONDED	0-2%	P	1	46
BISCAY	0-2%	P	1	40, 46, 77
BISCAY 24-32" TO SAND G	0-2%	P	1	37
BISCAY 32-40" TO SAND G	0-2%	P	1	8, 13, 14, 25, 30, 32, 37, 41, 55, 60, 71, 72, 76, 81, 84, 85, 99
BISCAY DEEP	0-2%	P	1	11, 21, 74, 94
BISCAY PONDED	0-1%	VP	1	41
BLOCKTON VARIANT	0-2%	P	2	9
BLUE EARTH	0-1%	VP	1	8, 11, 30, 32, 40, 41, 55, 74, 76, 81, 95
BLUE EARTH	1-5%	VP	1	32
BLUE EARTH PONDED	0-1%	VP	1	30
BLUE EARTH SANDY SUB	0-1%	VP	1	40
BOOTS	0-1%	VP	1	95, 98
BREMER	0-2%	P	2	2, 7, 12, 15, 27, 38, 48, 50, 52, 61, 62, 63, 64, 65, 69, 73, 77, 78, 79, 86, 91, 92
BREMER OVERWASH	0-1%	P	2	48
BREMER SANDY SUB	0-2%	P	2	6, 70
BREMER VARIANT	0-2%	P	2	7
BROWNTON	0-2%	P	2	40, 41, 99
CALCO	0-1%	P	1	97
CALCO	0-2%	P	1	8, 11, 12, 13, 14, 15, 17, 21, 23, 30, 32, 34, 35, 37, 38, 39, 42, 55, 60, 65, 66, 71, 74, 75, 81, 84, 94, 98
CALCO FREQ FLOODED	0-2%	P	1	41
CALCOUSTA	0-1%	VP	1	32, 37, 40, 46, 76, 77, 99
CANEEK	0-2%	P	1	31, 49, 70
CANEEK CHanneled	0-2%	P	1	3, 31
CANISTEO	0-2%	P	1	8, 11, 13, 14, 17, 21, 25, 30, 32, 34, 35, 37, 39, 40, 41, 42, 46, 50, 55, 64, 66, 72, 74,

				76, 77, 81, 85, 94, 95, 98, 99
CANISTEO GYPSIC VAR	0-2%	P	1	21
CHARITON	0-2%	P	2	2
CHEQUEST	0-2%	P	2	
				4, 26, 27, 51, 54, 56, 59, 89, 93
CHEQUEST OVERWASH	0-2%	P	2	54, 59
CLYDE	0-2%	P	1	17, 23, 31, 35, 53, 98
CLYDE	0-2%	P-VP	1	6, 9
CLYDE	0-3%	P	1	
				7, 10, 12, 19, 28, 34, 38, 45, 57, 66, 82
CLYDE	0-3%	P-VP	1	96
CLYDE	1-3%	P	1	22, 33
CLYDE-FLOYD COMPLEX	0-4%	P	1	28
CLYDE-FLOYD COMPLEX	1-4%	P	1	7, 12, 17, 33, 38, 45
CLYDE-FLOYD COMPLEX	1-4%	P-VP	1	6, 10, 35
CLYDE-SCHLEY COMPLEX	1-4%	P	1	23
COLAND	0-2%	P	1	
				7, 8, 12, 13, 14, 17, 18, 19, 25, 29, 30, 32,
				33, 34, 35, 37, 38, 40, 41, 42, 46, 50, 52,
				55, 58, 64, 66, 72, 76, 77, 81, 85, 95, 98, 99
COLAND	2-4%	P	1	13
COLAND	2-5%	P	1	50, 70, 76, 81, 95
COLAND CHANNELED	0-1%	P	1	37
COLAND CHANNELED	0-2%	P	1	8, 33, 35, 41, 55, 99
COLAND RARELY FLOODED	0-2%	P	1	70
COLAND-HANLON COMPLEX	0-2%	P	1	17
COLAND-PERKS-LAWSON FF	0-2%	P	1	58
COLAND-SPILLVILLE CHANNELED	0-2%	P	1	32, 37
COLAND-SPILLVILLE CHANNELED	2-5%	P	1	13, 37, 81
COLAND-SPILLVILLE COMPLEX	0-2%	P	1	10, 34
COLAND-SPILLVILLE COMPLEX	0-5%	P	1	30, 95
COLAND-SPILLVILLE COMPLEX	1-5%	P	1	37
COLAND-SPILLVILLE COMPLEX	2-5%	P	1	8, 13, 14, 32, 81
COLAND-SPLVL-HANLON CHANNELED	0-2%	P	1	42
COLAND-SPLVL-HANLON COMPLEX	0-2%	P	1	42
COLAND-TERRIL COMPLEX	1-4%	P	1	12, 17
COLAND-TERRIL COMPLEX	1-5%	P	1	34, 35, 40, 77, 85, 99
COLAND-TERRIL COMPLEX	2-5%	P	1	25, 42, 64, 72
COLAND-TURLIN COMPLEX	0-2%	P	1	98
COLO	0-1%	P	1	97
COLO	0-2%	P	1	
				1, 2, 4, 5, 6, 7, 9, 11, 12, 14, 15, 16, 18, 20,
				21, 22, 23, 24, 25, 29, 32, 35, 36, 38, 39,
				42, 43, 44, 45, 47, 48, 49, 50, 52, 53, 54,
				55, 56, 57, 58, 60, 61, 62, 63, 64, 65, 67,
				68, 69, 70, 71, 73, 74, 75, 77, 78, 79, 81,
				82, 83, 84, 86, 87, 88, 89, 90, 91, 92, 93, 94
COLO	2-4%	P	1	55, 74

COLO	2-5%	P	1	4, 20, 21, 29, 39, 44, 54, 62, 63, 64, 68, 70, 87, 88, 91, 93
COLO CALC OVERWASH	0-1%	P	1	75, 97
COLO CHANNELED	0-2%	P	1	2, 6, 7, 16, 21, 32, 38, 39, 44, 55, 61, 64, 86, 95
COLO OVERWASH	0-2%	P	1	1, 2, 4, 14, 15, 16, 23, 24, 28, 36, 39, 43, 44, 47, 48, 50, 52, 54, 57, 58, 62, 63, 64, 65, 68, 69, 73, 78, 79, 83, 86, 87, 90, 92
COLO OVERWASH	2-5%	P	1	39, 87
COLO RARELY FLOODED	0-2%	P	1	70
COLO SIC SUB	0-2%	P	1	83
COLO-ACKMORE COMPLEX	0-5%	P	1	87
COLO-ALLUVIAL LAND	0-2%	P	1	45
COLO-ELY	2-5%	P	1	35
COLO-ELY COMPLEX	0-5%	P	1	23, 49, 58, 79, 81
COLO-ELY COMPLEX	2-5%	P	1	1, 6, 7, 12, 16, 28, 54, 57, 61, 64, 88, 90, 91
COLO-ELY SICL	2-5%	P	1	42, 48
COLO-GRAVITY COMPLEX	2-5%	P	1	2
COLO-HANLON-LAWSON CHANNELED	0-2%	P	1	17, 64
COLO-JUDSON COMPLEX	0-5%	P	1	36, 47
COLO-JUDSON COMPLEX	2-5%	P	1	39, 65, 73, 77
COLO-JUDSON SICI	2-5%	P	1	14
COLO-JUDSON SICL	0-5%	P	1	18
COLO-JUDSON-NODAWAY	0-2%	P	1	87
COLO-NODAWAY COMPLEX	0-2%	P	1	15
COLO-OTTER-OSSIAN COMPLEX	2-5%	P	1	96
COLO-SPILL COMPLEX CHANNELED	2-5%	P	1	39
COLO-SPILLVILLE CHANNELED	0-2%	P	1	11
COLO-SPILLVILLE COMPLEX	0-2%	P	1	9
COLO-SPILLVILLE COMPLEX	2-5%	P	1	11, 39, 55, 74, 94
COLO-TERRIL COMPLEX	2-5%	P	1	9, 21
COLO-VESSER COMPLEX	2-5%	P	1	56
COLO-ZOOK COMPLEX	0-3%	P	1	51
COPPOCK	0-2%	P	1	49, 51, 92
COPPOCK	2-5%	P	1	92
COPPOCK SANDY SUB	0-2%	P	1	70
CORDOVA	0-2%	P	2	37, 85, 94, 95
CORLEY	0-1%	P	1	65, 97
CORLEY	0-2%	P	1	15, 36, 83
CORLEY BENCHES	0-1%	P	1	83
CORLEY BENCHES	0-2%	P	1	69, 78
DARFUR	0-1%	P	1	95
DARFUR	0-2%	P	1	55
DARWIN BEDROCK SUB	0-2%	VP	2	23
DARWIN VARIANT	0-2%	P	2	23
DELFT	1-3%	P	1	32
DELFT-TERRIL COMPLEX	2-5%	P	1	32
DOCKERY	0-2%	P	1	56
DOLBEE	0-2%	P	1	29, 49
DOLBEE	2-5%	P	1	49

DOLBEE SANDY SUB	0-2%	P	1	70
DU PAGE-CALCO COMPLEX	0-2%	P	1	34
DU PAGE-SHELLWD-CALCO	0-3%	P	1	34
DUNDAS	0-2%	P	1	8, 37, 94, 95
ELVERS	0-1%	VP	1	70
ELVERS	0-2%	P	1	23
ELVIRA	0-2%	P	1	23, 52
FAXON	0-2%	P	1	17, 34, 76, 98
FIELDON	0-2%	P	1	41, 55
FLOYD-CLYDE COMPLEX	1-4%	P-VP	1	96
FLUVAQUENTS, PONDED	N/A	P	1	67
FLUVAQUENTS-OMADI CHANNELED	0-2%	P	1	18
GARWIN	0-2%	P	1	3, 6, 7, 12, 16, 23, 35, 38, 42, 49, 50, 52,
				53, 57, 58, 64, 66, 70, 79, 82, 86
GARWIN BENCHES	0-2%	P	1	23, 82
GARWIN SANDY SUB	0-2%	P	1	23
GARWIN-SPERRY COMPLEX	0-2%	P-VP	2	50
GILFORD	0-2%	VP	1	58
GLENCOE	0-1%	VP	2	21
GLENCOE GRAVELLY SUBST	0-1%	P	1	21
GRANBY	0-2%	P	1	23
GRANBY	0-2%	VP	1	53
GRAVITY	2-5%	P	1	2
HANSKA	0-2%	P	1	55, 64, 74, 76, 95
HANSKA	1-4%	P	1	12
HARCOT	0-2%	P	1	8, 17, 35, 41, 42, 55, 98
HARPS	0-2%	P	1	8, 11, 13, 14, 21, 25, 30, 37, 39, 40, 41, 46,
				55, 64, 72, 74, 76, 77, 81, 94, 99
HARPS	1-3%	P	1	17, 32, 35, 42, 85, 95, 98
HARPS-OKOBOJI COMPLEX	0-1%	P-VP	1	25
HARPS-OKOBOJI COMPLEX	0-1%	P-VP	2	40, 99
HARPS-OKOBOJI COMPLEX	0-1%	VP	1	77
HARPS-OKOBOJI COMPLEX	0-2%	P-VP	2	41
HARPS-OKOBOJI COMPLEX	0-2%	VP	2	85
HARPSTER	0-2%	P	1	9, 35, 38, 41, 42, 55, 64
HARPSTER SICL	0-2%	P	1	34
HAVANA	0-2%	P	2	19
HAVELOCK	0-2%	P	1	72, 76
HAVELOCK CHANNELED	0-2%	P	1	76
HOLLY SPRINGS	0-1%	P-VP	2	97
HOUGHTON	0-1%	VP	1	17, 35, 41, 95, 98
HOUGHTON	0-2%	VP	1	12, 52
HOUGHTON	2-5%	VP	1	19
HOUGHTON PONDED	0-1%	VP	1	70
HUMESTON	0-1%	P	2	48, 59
HUMESTON	0-1%	VP	2	86
HUMESTON	0-2%	P	2	4, 15, 20, 26, 27, 39, 62, 69, 80, 87, 88,
				91, 93
HUMESTON	0-2%	P-VP	2	1, 90
HUMESTON	0-2%	VP	2	54, 92
HUMESTON	2-5%	P	2	4, 80, 93

HUMESTON OVERWASH	0-2%	P	2	59, 80, 87
HUMESTON OVERWASH	2-5%	P	2	80
HUMESTON-VESSER-COLO	2-5%	P-VP	1	90
JAMESTON	0-2%	P	2	19, 34, 45, 66
JUDSON-COLO COMPLEX	2-5%	P	1	15
JUDSON-COLO-ACKMORE	2-5%	P	1	5
JUDSON-COLO-NODAWAY	2-5%	P	1	24
JUDSON-NODAWAY-COLO	2-5%	P	1	83
KALONA	0-1%	P	2	29, 44, 51, 58, 90
KALONA	0-2%	P	2	92
KALONA BENCHES	0-1%	P	2	44
KENNEBEC-ACKMORE COMPLEX	2-5%	P	1	81
KENNEBEC-ACKMORE COMPLEX CHANN	2-5%	P	1	81
KLOSSNER MUCK	0-1%	VP	1	46
KNOKE	0-1%	VP	1	13, 14, 37, 40, 72, 76, 77, 99
KNOKE PONDED	0-1%	VP	1	13, 37, 76
KOSSUTH	0-2%	P	2	13, 40, 41, 55, 76, 85, 99
LEMOND	0-2%	P	1	55
LETRI	0-1%	P	1	30
LETRI	0-2%	P	1	72, 81
LETRI CALC	0-2%	P	1	72
MADELIA	0-2%	P	1	30
MARCUS	0-2%	P	1	11, 18, 21, 30, 47, 60, 71, 72, 81, 84
MARNA VARIANT	0-2%	P	2	21
MARSHAN	0-2%	P	1	23, 58
MARSHAN 24-32" TO SAND G	0-2%	P	1	7, 10, 12, 17, 19, 28, 33, 34, 35, 57, 66, 82
MARSHAN 32-40" TO SAND G	0-2%	P	1	7, 10, 12, 17, 19, 28, 31, 33, 34, 35, 42, 52, 53, 57, 66, 70
MARSHAN DEEP	0-2%	P	1	9, 38, 45, 56, 98
MARSHAN DEPRESSIONAL	0-1%	VP	1	9, 28, 98
MARSHAN DEPRESSIONAL	0-2%	VP	1	45
MARSHAN MODERATELY DEEP	0-2%	P	1	9, 98
MAXFIELD	0-2%	P	1	6, 7, 9, 10, 12, 16, 17, 23, 34, 35, 38, 42, 52, 53, 57, 66, 82, 98
MAYER	0-2%	P	1	46, 74, 95
MAYER 24-32" TO SAND G	0-2%	P	1	37, 41, 55
MAYER 32-40" TO SAND G	0-2%	P	1	37, 41
MAYER MODERATELY DEEP	0-2%	P	1	74
MILLINGTON	0-2%	P	1	37
MILLINGTON CHANNELED	0-2%	P	1	11, 13, 30, 32
MINNETONKA	0-2%	P	2	17, 94, 95
MINNETONKA	1-3%	P	2	98
MT. STERLING	0-2%	P	2	89
MUCK	0-2%	VP	1	66
MUCK DEEP	0-2%	VP	1	45
MUCK MOD SHALLOW	0-1%	VP	1	21
MUCK MOD SHALLOW	1-4%	VP	1	57
MUCK MODERATELY DEEP	1-4%	VP	1	45
MUCK SHALLOW	0-1%	VP	1	21, 94
MUCK SHALLOW	1-4%	VP	1	45, 57
MUSKEGO	0-1%	VP	1	41, 95

MUSKEGO	0-2%	VP	1	32
MUSKEGO PONDED	0-1%	VP	1	95
NODAWAY-VESSER COMPLEX	2-5%	P	1	88
OKAW	0-2%	P	2	26, 44, 68
OKAW	0-2%	P-VP	2	29, 51, 89
OKAW	0-2%	VP	2	92
OKAW	0-3%	P	2	56
OKAW	2-5%	P	2	44
OKAW	2-5%	P-VP	2	29
OKOBOJI	0-1%	VP	1	8, 13, 14, 21, 25, 32, 35, 37, 40, 41, 42, 46,
				55, 72, 74, 76, 77, 85, 94, 95, 99
OKOBOJI	0-1%	VP	2	8, 11, 13, 14, 17, 25, 30, 32, 35, 37, 39, 40,
				41, 42, 46, 55, 64, 72, 74, 76, 77, 81, 85,
				94, 95, 98, 99
OKOBOJI BENCHES	0-1%	VP	2	74
OKOBOJI-HARPS COMPLEX	0-2%	P-VP	2	32
OKOBOJI-HARPS COMPLEX	0-2%	VP	1	35, 42
OKOBOJI-HARPS COMPLEX	0-3%	VP	1	17, 98
OLMITZ-COLO COMPLEX CHANNELED	2-5%	P	1	39
OLMITZ-VESSER-COLO COMPLEX	2-5%	P	1	4, 93
OLMITZ-VESSER-ZOOK COMPLEX	0-5%	P	1	51
OLMITZ-VESSER-ZOOK COMPLEX	2-5%	P	1	89
OLMITZ-ZOOK-COLO COMPLEX	2-5%	P	1	20
OLMITZ-ZOOK-VESSER COMPLEX	0-5%	P	1	27
OSSIAN	0-2%	P	1	22, 28, 33, 53, 62
OSSIAN	0-3%	P	1	96
OTTER	0-2%	P	1	3, 22, 49
OTTER AND OSSIAN OVER	0-1%	P	1	96
OTTER OVERWASH	0-2%	P	1	22, 31
OTTER-HUNTSVILLE COMPLEX	0-5%	P	1	33
OTTER-LAWSON-OSSIAN	1-4%	P	1	96
OTTER-OSSIAN COMPLEX	0-2%	P	1	96
OTTER-WORTHEN COMPLEX	1-4%	P	1	3
OTTER-WORTHEN SIL	1-4%	P	1	22
OTTER-WORTHEN SIL	2-5%	P	1	31
PALMS	0-1%	VP	1	8, 17, 23, 32, 35, 40, 41, 55, 74, 81, 85, 95,
				98, 99
PALMS	0-2%	VP	1	42
PALMS	0-3%	VP	1	53
PALMS	1-3%	VP	1	16, 38
PALMS	1-4%	VP	1	6, 7, 10, 17, 19, 22, 28, 33, 98
PALMS	0-5%	VP	1	34
PALMS	2-5%	VP	1	12
PALMS MUCK	0-1%	VP	1	77
PALMS PEATY MODERATELY DEEP	0-1%	VP	1	9
PALMS PEATY MUCK DEEP	0-1%	VP	1	9
PALMS PONDED	0-1%	VP	1	40, 41
PALMS SANDY SUB	0-1%	VP	1	70
PEATY MUCK OVERWASH	0-2%	VP	1	96
RACoon	0-2%	P	1	56, 89

RADFORD	0-2%	P	1	70
RADFORD	2-5%	P	1	70
RADFORD-HANLON CHANNELED	0-2%	P	1	70
REVERE	0-2%	P	1	72
ROCKSAN	0-2%	P	1	34
ROLFE	0-1%	VP	2	9, 11, 13, 17, 21, 30, 41, 46, 55, 72, 74, 76, 81, 85, 94, 98
RUBIO	0-1%	P	2	54
RUBIO	0-2%	P	2	58, 92
RUBIO	0-2%	P-VP	2	29, 51, 62
RUSHVILLE	0-2%	P-VP	2	56
RUSHVILLE BENCHES	0-2%	P	2	44
RUSHVILLE BENCHES	0-2%	P-VP	2	56
SABLE	0-2%	P	1	9
SAWMILL	0-2%	P	1	7, 16, 23, 35, 38, 42, 53
SAWMILL	1-3%	P	1	28
SAWMILL	2-5%	P	1	86
SAWMILL-GARWIN COMPLEX	0-3%	P	1	38
SHANDEP	0-1%	VP	1	12, 17, 19, 35, 53
SPERRY	0-1%	P-VP	2	6, 16, 21, 29, 44, 48, 50, 51, 52, 60, 79, 90, 91
SPERRY	0-1%	VP	2	18, 38, 42, 58, 61, 70, 71, 86
SPERRY	0-2%	P-VP	2	62, 88
SPERRY	0-2%	VP	2	2, 54, 64, 92
SPERRY BENCHES	0-1%	P-VP	2	44
SPERRY BENCHES	0-2%	VP	2	2
SPICER	0-2%	P	2	11, 30, 41, 55, 60, 71, 72, 84
SPILLV-HANLON-COLND CHANNELED	0-3%	P	1	34
SPILLVILLE-COLAND CHANNELED	0-2%	P	1	10, 12, 28, 40
SPILLVILLE-COLAND CHANNELED	2-5%	P	1	76
SPILLVILLE-COLAND COMPLEX	0-2%	P	1	12, 28, 53
SPILLVILLE-COLAND COMPLEX	1-5%	P	1	18
SPILLVILLE-COLAND COMPLEX, CHA	0-2%	P	1	77
SPILLVILLE-COLO COMPLEX	0-2%	P	1	45
SPILLVL-COLO COMPLEX CHANNELED	0-2%	P	1	45
TAINTOR	0-1%	P	2	29
TAINTOR	0-2%	P	2	44, 48, 50, 51, 52, 54, 58, 62, 63, 68, 79, 90, 92
TAINTOR BENCHES	0-2%	P	2	44, 54, 62, 68, 90
TALCOT	0-2%	P	1	40
TALCOT 24-32" TO SAND G	0-2%	P	1	17
TALCOT 32-40" TO SAND G	0-2%	P	1	8, 13, 14, 17, 30, 32, 34, 35, 55, 72, 76, 81, 85, 99
TALCOT DEEP	0-2%	P	1	11, 21, 74, 94, 98
TALCOT MODERATELY DEEP	0-2%	P	1	11, 94, 98
THORP	0-1%	P	1	12
THORP	0-2%	P	1	23, 38
TILFER	0-2%	P	1	17, 98
TILFER L	0-2%	P	1	42
TITUS	0-2%	P	2	29, 58

TITUS RARELY FLOODED	0-2%	P	2	58
TOOLESBORO	0-2%	P	1	58, 70
TRAER	0-2%	P	1	58, 70, 86
TRIPOLI	0-2%	P	1	21
TRIPOLI	0-2%	P	2	
				6, 7, 9, 10, 12, 17, 19, 33, 34, 35, 45, 57, 66
TUSKEEGO SANDY SUB	0-2%	P	2	58, 70
UDOLPHO 24-32" TO SAND G	0-2%	P	1	19
UDOLPHO 32-40" TO SAND G	0-2%	P	1	70
VESSER	0-2%	P	2	20, 23, 26, 39, 51, 61, 68
VESSER	2-5%	P	2	20, 26, 61, 70
VESSER OVERWASH	0-2%	P	2	26, 39
VESSER OVERWASH	2-5%	P	2	26
VESSER-COLO COMPLEX	2-5%	P	1	44
VESSER-NODAWAY COMPLEX	2-5%	P	1	1
WACOUSTA	0-1%	VP	2	
				11, 13, 21, 35, 37, 40, 41, 42, 46, 55, 74,
				76, 81, 85, 94, 99
WACOUSTA BENCHES	0-2%	P	2	98
WACOUSTA STR SUB	0-1%	VP	1	41
WACOUSTA VARIANT	0-1%	VP	1	13
WALDORF SILTY SUB	0-2%	P	2	55
WALFORD	0-1%	P	2	16, 23, 52, 58
WALFORD	0-2%	P	2	57, 70
WALFORD	0-2%	P-VP	2	82
WALFORD BENCHES	0-1%	P	2	16, 23, 52, 57
WALFORD BENCHES	0-1%	P-VP	2	48
WALFORD BENCHES	0-2%	P	2	49
WALFORD SANDY SUB	0-1%	P-VP	2	6
WEBSTER	0-2%	P	1	
				8, 11, 13, 14, 17, 21, 25, 30, 32, 35, 37, 39,
				40, 41, 42, 46, 50, 55, 64, 72, 74, 76, 77,
				81, 85, 94, 95, 98, 99
WEBSTER BENCHES	0-3%	P	1	94
WEBSTER-NICOLLET COMPLEX	1-3%	P	1	17, 35, 98
WINTERSET	0-2%	P	2	
				1, 2, 20, 61, 63, 80, 87, 88, 91
WINTERSET BENCHES	0-2%	P	2	73
WORTHEN-OTTER SIL	0-5%	P	1	49
ZOOK-OLMITZ-VESSER COMPLEX	2-5%	P	1	59

Table 8, Soils listing for estimating subsurface drainage

(Soils with moderately rapid, rapid, and very rapid permeable subsoils/substrata)

It contains a list of sorted soil names (and a list of associated county numbers) where:

Permeability : 00 through 35, 58, 72, 75 (Proxy for Coarse Texture Subsoil/Substrate)

It includes all slopes.

From the Iowa Soil Properties And Interpretations Database (ISPAID) 7.0 Manual:

21 Slope Range (%) High [SLOPERNGH]

The incline of the surface of a soil. It is expressed in percentages of slope which equal the number of feet of fall per 100 feet of horizontal distance.

56 Permeability Code [PERMCODE]

The quality of the soil that enables water to move through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. If the clayey material or the residuum overlying bedrock is 1 to 5 inches thick and continuous, the permeability is slower than the overlying material. A slash indicates that two materials with different permeabilities occur; i.e., MR/S means moderately rapid over slow.

[Permeability listed for complexes is the most limiting class of the soils identified in the map unit name (i.e., Marshall = moderate and Dickman = moderately rapid over rapid; Marshall-Dickman complex = moderately rapid over rapid).]

Permeability class abbreviations and code numbers assigned are:

VR	= 00 = Very rapid [>20.0 in/hr]
R/VR	= 05 = Rapid/Very rapid
R	= 10 = Rapid [6.0-20.0 in/hr]
MR/VR	= 15 = Moderately rapid/Very rapid
MR/R	= 20 = Moderately rapid/Rapid
M/VR	= 25 = Moderate/Very rapid
MR	= 30 = Moderately rapid [2.0-6.0 in/hr]
M/R	= 35 = Moderate/Rapid
R/M	= 40 = Rapid/Moderate
MR/M	= 45 = Moderately rapid/Moderate
M	= 50 = Moderate [0.6-2.0 in/hr]
MS	= 55 = Moderately slow [0.2-0.6 in/hr]
MS/M	= 56 = Moderately slow/Moderate
MR/MS	= 57 = Moderately rapid/Moderately slow
MS/R	= 58 = Moderately slow/Rapid
R/S	= 60 = Rapid/Slow
MR/S	= 65 = Moderately rapid/Slow
M/S	= 70 = Moderate/Slow
S/R	= 72 = Slow/Rapid
VS/R	= 75 = Very slow/Rapid
S	= 80 = Slow [0.06-0.20 in/hr]
M/VS	= 85 = Moderate/Very slow
VS	= 90 = Very slow [<0.06 in/hr]

ADRIAN	MR/R	41
AINSWORTH	M/R	44, 51, 92
AINSWORTH-LAMONT COMPLEX	M/R	44
ALLENDORF	M/VR	18, 47, 72, 84
AMANA-LAWSON-PERKS	R	48
AMANA-LAWSON-PERKS	MR/R	52
AMBRAW	M/R	70
AMBRAW RARELY FLOODED	M/R	70
AMBRAW-PERKS-LAWSON FF	MR/R	82
ANKENY	MR	15, 22, 45, 53, 70, 77, 85, 94
ARENZVIL-VOLNEY	MR/VR	3
ARTHUR	M/R	47
ATTERBERRY SANDY SUB	M/R	23, 53, 57
AUREOLA	M/R	34
BACKBONE	MR	10
BERTRAM	MR	10, 53
BERTRAND	M/R	70
BERTRAND-CHELSEA	R	3
BILLETT	MR/R	19, 49, 53, 94
BISCAY	M/VR	46, 77
BISCAY	M/R	40
BISCAY 24-32" TO SAND G	M/VR	37
BISCAY 32-40" TO SAND G	M/VR	8, 13, 14, 25, 30, 32, 37, 55, 60, 71, 72, 76, 81, 84, 85, 99
BISCAY 32-40" TO SAND G	M/R	41
BISCAY DEEP	M/VR	11, 21, 74, 94
BISCAY PONDED	M/R	41
BIXBY	M/R	33, 66, 96
BLUE EARTH SANDY SUB	M/R	40
BOLAN	M/R	12, 17, 28, 29, 30, 34, 35, 38, 41, 47, 50, 52, 53, 58, 60, 70, 71, 81, 82, 84, 86, 98
BOLAN VARIANT	MR	84
BOONE	R	3, 54, 62, 94
BOOTS	MR	95, 98
BRADY	MR/VR	16, 23, 53
BREMER SANDY SUB	MS/R	70
BUCKNEY	R	8, 36, 65, 94
BUCKNEY CHANNELED	R	8
BURKHARDT	VR	45
BURKHARDT	R	23, 28, 33
BURKHARDT	MR/VR	6, 9, 12, 19, 31, 34, 52, 57, 66
BURKHARDT SOILS	MR/VR	96
BURKHARDT-SAUDE COMPLEX	R	28
BURKHARDT-SAUDE COMPLEX	MR/R	10
CAMDEN	M/R	33, 96
CANOE SANDY SUB	M/R	70
CARR	MR/R	36, 43
CARR	MR	97
CHASEBURG-PERKS COMPLEX	R	49
CHELSEA	R	3, 6, 7, 9, 10, 12, 16, 19, 22, 23, 28, 31, 33, 34, 48, 49, 50, 52, 53, 54, 56, 57, 58, 62, 63, 64, 70, 82, 86, 91, 96

CHELSEA SOILS	R	56
CHELSEA-CLINTON COMPLEX	R	62
CHELSEA-FAYETTE	R	51
CHELSEA-FAYETTE COMPLEX	R	50,70
CHELSEA-LADOGA COMPLEX	R	79
CHELSEA-LAMONT-FAYETTE	R	6,16,23,44,48,52,53,57,58,82,86
CHUTE	R	24,97
CLARION-ESTHERVIL COMPLEX	MR/VR	74
CLARION-SUNBURG COMPLEX	MR	41
COLAND-HANLON COMPLEX	MR	17
COLAND-PERKS-LAWSON FF	R	58
COLAND-SPLVL-HANLON CHANNELED	MR	42
COLAND-SPLVL-HANLON COMPLEX	MR	42
COLO-HANLON-LAWSON CHANNELED	MR	17,64
COPPOCK SANDY SUB	M/R	70
COTT	M/R	36
COYNE	MR/R	23
CURRAN	M/R	53
CYLINDER	M/VR	39,40,46,60,71,77,84
CYLINDER 24-32" TO SAND G	M/VR	13,30,37,72,76,81,85
CYLINDER 32-40" TO SAND G	M/VR	8,13,14,25,30,37,55,72,76,81,85,99
CYLINDER DEEP	M/VR	11,21,74,94
CYLINDER MOD. DEEP	M/VR	11
CYLINDER MODERATELY DEEP	M/VR	21,94
CYLINDER VARIANT	M/VR	30
DELLS	M/R	7,10,53
DEMPSTER 24-32" TO SAND G	M/VR	60
DEMPSTER 32-40" TO SAND G	M/VR	60
DICKINSON	MR/R	1,6,7,9,10,11,12,16,17,19,21,23,25,28, 29,31,33,34,35,38,40,44,45,46,49,50, 52,53,56,57,58,64,66,69,70,77,80,82, 85,86,88,92,95,96,98,99
DICKINSON	M/R	21
DICKINSON BENCHES	MR/VR	21
DICKINSON BENCHES	MR/R	9
DICKINSON FSL	MR/R	48
DICKINSON GR SUB	MR/R	9
DICKINSON-OSTRANDER	MR/R	9,45,66
DICKINSON-RACINE COMPLEX	MR/R	45
DICKINSON-SHARPSBURG	MR/R	1,39
DICKINSON-SPARTA COMPLEX	MR/R	54
DICKINSON-SPARTA-LADOG	R	54
DICKINSON-SPARTA-TAMA	R	57
DICKINSON-SPARTA-TAMA	MR/R	64
DICKINSON-TAMA COMPLEX	MR/R	16
DICKMAN	R	75
DICKMAN	MR/R	8,14,18,30,32,37,41,47,55,60,72,95
DICKMAN	MR	84
DICKMAN-MARSHALL COMPLEX	MR/R	5
DOLBEE SANDY SUB	M/R	70
DORCHESTER-VOLNEY COMPLEX	MR/VR	22,31,33

DOUDS	M/R	56
DOWNS SANDY SUB	M/R	58, 70, 82
DOWNS VARIANT	M/VR	42
DOWNS-CHELSEA COMPLEX	MR/R	79
DOWNS-LAMONT COMPLEX	MR/R	86
DU PAGE-SHELLWD-CALCO	MR	34
ELRICK	MR/VR	58, 70
ELRIN	M/R	29, 70, 92
ELVIRA	M/R	23, 52
ESTHERVILLE	MR/VR	11, 13, 14, 18, 30, 32, 37, 41, 55, 60, 71, 74, 76, 84, 85, 94
ESTHERVILLE-SALIDA COMPLEX	VR	60, 76
FAIRHAVEN 24-32" TO SG	M/VR	71
FAIRHAVEN 32-40" TO SG	M/VR	71
FAYETTE SANDY SUB	M/R	58, 70
FAYETTE-LAMONT-CHELSEA	R	92
FIELDON	M/R	41, 55
FINCHFORD	VR	6, 7, 10, 23, 28, 49, 53
FLAGLER	MR/VR	6, 7, 10, 12, 17, 19, 22, 23, 28, 31, 33, 34, 35, 42, 50, 52, 53, 57, 62, 66, 82, 85, 98
FLAGLER CALC SUB VAR	MR/VR	74, 81
FRUITFIELD	VR	58, 70
GALE	M/R	70
GALVA STR SUB	M/VR	60, 71, 72
GALVA-WADENA COMPLEX	M/VR	75
GARWIN SANDY SUB	M/R	23
GILFORD	MR/R	58
GLENCOE GRAVELLY SUBST	M/VR	21
GRABLE	M/R	36, 43, 65, 67, 78, 97
GRACEVILLE	M/VR	84
GRANBY	R	23, 53
HAGENER	R	2, 21, 96
HAGENER BENCHES	R	9
HAGENER SOILS	R	15
HANLON	MR	6, 8, 16, 17, 25, 33, 34, 40, 42, 46, 64, 66, 85, 94, 99
HANLON CHANNELED	MR	40, 99
HANLON-SPILL COMPLEX CHANNELED	MR	25
HANLON-SPILLVILLE CHANNELED	MR	85
HANSKA	MR/R	12, 55, 64, 74, 76, 95
HARCOT	MR/VR	41
HARCOT	M/VR	8, 17, 35, 42, 55, 98
HAWICK	VR	3, 18, 47
HAYFIELD 24-32" TO SAND G	M/VR	7, 10, 17, 19, 28, 33, 34, 57, 66
HAYFIELD 24-40" TO SAND G	M/VR	7, 31, 34, 53, 57, 66
HAYFIELD DEEP	M/VR	9, 45, 96, 98
HAYFIELD MODERATELY DEEP	M/VR	9, 45, 96, 98
HAYFIELD VARIANT	M/VR	9
HESCH	MR	39
HESCH VARIANT	M/R	69
HIXTON	MR/R	61
HOOPESTON	MR/R	12, 17, 19, 29, 44, 52, 56, 58, 70, 89, 90, 98

HOOPESTON	M/R	58
HOOPESTON VARIANT	MR/R	72
HOUGHTON PONDED	MR	70
IDA-WADENA COMPLEX	MR	75
KANARANZI VARIANT	M/R	72
KATO DEEP	M/VR	96
KATO MODERATELY DEEP	M/VR	96
KLUM	MR	27, 29, 44, 51, 58, 77, 89
KLUM CALCAREOUS	MR	29
KLUM-PERKS-NODAWAY CHANNELED	R	44
KLUM-PERKS-NODAWAY COMPLEX	R	44
LACRESCENT	M/R	3
LADOGA-CHELSEA COMPLEX	R	91
LAMONT	MR/R	6, 7, 10, 12, 16, 22, 23, 28, 31, 33, 34, 44, 45, 49, 52, 53, 57, 58, 66, 86, 96
LAMONT BENCHES	MR/R	9
LAMONT-CLINTON-CHELSEA	R	54
LAMONT-RENOVA COMPLEX	MR/R	66
LANDES	R	63
LANDES	MR	56, 62, 90
LANDES-PERKS COMPLEX CHANNELED	R	90
LAWLER	M/VR	23
LAWLER 24-32" TO SAND G	M/VR	7, 10, 12, 17, 19, 22, 28, 33, 34, 35, 42, 50, 57, 66, 82
LAWLER 32-40" TO SAND G	M/VR	6, 7, 10, 12, 17, 19, 22, 28, 33, 34, 35, 42, 48, 50, 52, 53, 56, 57, 64, 66, 86
LAWLER DEEP	M/VR	9, 38, 45, 98
LAWLER MODERATELY DEEP	M/VR	9, 38, 45, 98
LEMOND	MR/R	55
LILAH	VR	10
LILAH	MR/VR	7, 19, 22, 28, 34, 38, 45, 66
LINDER	MR/VR	8, 32, 41, 55, 74, 95
LINDER 24-32" TO SAND G	MR/VR	76
LINDER 32-40" TO SAND G	MR/VR	32, 41
MARLEAN	M/R	22, 31, 33, 35, 96
MARSHALL-DICKMAN COMP	MR/R	14
MARSHAN	M/VR	23, 58
MARSHAN 24-32" TO SAND G	M/VR	7, 10, 12, 17, 19, 28, 33, 34, 35, 57, 66, 82
MARSHAN 32-40" TO SAND G	M/VR	7, 10, 12, 17, 19, 28, 33, 34, 35, 42, 52, 53, 57, 66
MARSHAN 32-40" TO SAND G	M/R	31, 70
MARSHAN DEEP	M/VR	9, 38, 45, 56, 98
MARSHAN DEPRESSIONAL	M/R	9, 28, 45, 98
MARSHAN MODERATELY DEEP	M/VR	9, 98
MAYER	MR/R	74
MAYER	M/VR	46, 95
MAYER 24-32" TO SAND G	M/VR	37, 55, 60
MAYER 24-32" TO SAND G	M/R	41
MAYER 32-40" TO SAND G	M/VR	37
MAYER 32-40" TO SAND G	M/R	41
MAYER MODERATELY DEEP	M/VR	74
MONTIETH	MR/VR	39, 42

MORCONICK	M/R	67
MUSCATINE SANDY SUB	M/R	23
NODAWAY-COPPOCK COMPLEX	R	51, 89
NODAWAY-KLUM COMPLEX CHANNELED	MR	58
NODAWAY-KLUM-PERKS COMPLEX	R	51, 89
NODAWAY-LANDES COMPLEX	MR/R	90
NODAWAY-LAWSON COMPLEX	R	59
NODAWAY-PERKS COMPLEX	R	92
NODAWAY-PERKS COMPLEX CHANNELE	MR/R	82
OAKTON	M/R	34
OKOBOJI BENCHES	MS/R	74
PALMS SANDY SUB	MR/R	70
PEATY MUCK	R	96
PEATY MUCK OVERWASH	R	96
PERCIVAL	S/R	36, 43, 65, 67, 78, 97
PERCIVAL DARK SURFACE	S/R	65
PERKS	R	51, 58, 70, 82, 89
PERKS	MR/R	52, 53, 58, 82, 92
PERKS RARELY FLOODED	MR/R	58
PERKS VARIANT	R	26
PERKS-CHASEBURG COMPLEX	MR/R	53
PERKS-SPILL COMPLEX	MR/R	52
PILLOT	M/R	49, 70, 82
RADFORD-HANLON CHANNELED	MR	70
RICHWOOD	M/R	70
RIDGEPORT	MR/VR	8, 14, 25, 32, 41, 55, 95
ROCKSAN	M/R	34
ROWLEY	M/R	70
SALIDA	VR	8, 11, 17, 24, 30, 32, 35, 39, 41, 42, 55, 60, 71, 74, 81, 95, 97, 98
SALIDA GR SANDY LOAM	VR	21
SALIDA SANDY LOAM	VR	21
SALIDA-STORDEN COMPLEX	VR	14, 37
SANDY LAKE BEACHES	VR	21
SARPY	R	36, 43, 65, 67, 78, 97
SARPY SOILS AND ALLUVIAL	R	97
SATTRE	M/VR	3, 6, 8, 45, 52, 53, 57, 66
SATTRE DEEP	M/VR	9, 96
SATTRE MODERATELY DEEP	M/VR	9, 96
SAUDE	M/VR	6, 7, 10, 12, 16, 17, 19, 22, 23, 28, 33, 34, 35, 38, 42, 45, 53, 56, 57, 64, 66, 98
SAUDE-BURKHARDT COMPLEX	R	12
SAUDE-LILAH COMPLEX	R	38
SCHLEY SANDY SUB	M/R	28
SCROLL	S/R	67
SHAFFTON	M/R	58, 70
SHAFFTON RARELY FLOOD	M/R	58, 70
SHANDEP	M/R	12, 17, 19, 35, 53
SHELLWOOD	MR	34
SPARTA	R	6, 7, 12, 16, 17, 22, 23, 24, 28, 29, 31, 33, 34, 35, 38, 44, 45, 48, 49, 50, 51, 52, 53, 56, 57, 58, 62,

		64, 68, 70, 73, 76, 77, 79, 81, 82, 85, 90, 92, 98
SPARTA	MR/R	10
SPARTA LS	R	3
SPARTA S	R	3
SPARTA THICK SURFACE	R	52
SPARTA-OTLEY COMPLEX	VR	62
SPILLV-HANLON-COLND CHANNELED	MR	34
SPILLVILLE FLAGGY SUB	M/R	61
SPILLVILLE SANDY SUB	M/R	62
SPILLVILLE-BUCKNEY	R	8
STEEP SANDY LAND	R	96
STORDEN-HAWICK COMPLEX	VR	18
STORDEN-SALIDA COMPLEX	VR	8, 32, 55, 71, 74
SUNBURG	MR	41
SUNBURG-SALIDA COMPLEX	VR	41
TALCOT	M/R	40
TALCOT 24-32" TO SAND G	M/VR	17
TALCOT 32-40" TO SAND G	M/VR	8, 13, 14, 17, 30, 32, 34, 35, 55, 72, 76, 81, 85, 99
TALCOT DEEP	M/VR	11, 21, 74, 94, 98
TALCOT MODERATELY DEEP	M/VR	11, 94, 98
TAMA SANDY SUB	M/R	23, 52, 70, 82
TAMA-DICKINSON COMPLEX	MR/R	48, 52, 82
TELL	M/R	23, 28, 48, 57, 58
TERRIL SANDY SUB	M/R	19, 22, 28, 81, 94
THEBES	M/R	70
TOOLESBORO	MR/VR	58, 70
TURLIN	M/R	34, 35, 42, 66, 77, 94
TURLIN VARIANT	M/R	45
TUSKEEGO SANDY SUB	S/R	70
UDOLPHO	M/VR	23
UDOLPHO 24-32" TO SAND G	M/VR	19
UDOLPHO 32-40" TO SAND G	M/VR	6, 48, 52
UDOLPHO 32-40" TO SAND G	M/R	70
VOLNEY	MR/VR	3, 22
VOLNEY-DORCHESTER SIL	MR/VR	49
VORE	M/R	36, 43, 65, 67
WADENA	M/VR	40, 46, 77
WADENA 20-24" TO SAND G	M/VR	97
WADENA 24-30" TO SAND G	M/VR	97
WADENA 24-32" TO SAND G	MR/VR	76
WADENA 24-32" TO SAND G	M/VR	13, 14, 18, 30, 32, 37, 55, 72, 75, 81, 84, 85, 97, 99
WADENA 32-40" TO SAND G	MR/VR	76
WADENA 32-40" TO SAND G	M/VR	8, 13, 14, 25, 30, 37, 41, 55, 72, 81, 84, 99
WADENA 36-42" TO SAND G	M/VR	97
WADENA 42-48" TO SAND G	M/VR	97
WADENA DEEP	M/VR	11, 21, 39, 74, 94
WADENA MODERATELY DEEP	M/VR	11, 21, 39, 94
WADENA VARIANT	M/R	37
WADENA VARIANT DEEP	M/VR	94
WADENA VARIANT MODERATELY DEEP	M/VR	94
WAPSIE	M/VR	7, 10, 12, 17, 19, 22, 23, 28, 31, 33, 34, 45,

		57, 66, 95, 98
WAPSIE VARIANT	M/VR	23
WATSEKA	R	10, 52, 58, 70, 74, 76
WAUKEE	M/VR	3, 6, 7, 10, 12, 17, 22, 23, 28, 33, 34, 35, 38, 42,
		45, 48, 52, 53, 57, 64, 66, 90, 98
WAUKEE UPLANDS	M/VR	57
WAUKEEGAN MODERATELY DEEP	M/R	21
WAUKEGAN	M/VR	6, 12, 16, 23, 48, 52, 53, 57, 86
WAUKEGAN DEEP	M/VR	9, 96
WAUKEGAN MODERATELY DEEP	M/VR	9, 96
WHITTIER	M/VR	6, 16, 23, 49, 52, 53, 57, 58, 82
WHITTIER	M/R	70
WIOTA	M/VR	6
WIOTA SANDY SUB	M/VR	58
ZENOR	MR/VR	8, 25, 32, 35, 42, 46, 77, 85, 99
ZENOR	MR/R	40
ZENOR-STORDEN COMPLEX	MR/VR	8, 25, 40, 46, 77, 99
ZOOK SANDY SUB	S/R	82